



## REMARKS

Claims 1-11 are pending. The following remarks are being submitted as a full and complete response to the Office Action dated June 30, 2006.

### The Presently-Claimed Invention

The present claims are directed to a "process of manufacturing membrane-electrode assemblies, said process comprising pressure bonding an electrolyte membrane with electrode substrates to form a membrane-electrode assembly, wherein a good solvent for the electrolyte membrane is applied to at least one of facing surfaces of the opposed electrode substrate and the electrolyte membrane prior to the pressure bonding, wherein the good solvent is applied in an amount of from 0.001 mg/cm<sup>2</sup> to 10 mg/cm<sup>2</sup>."

The presently claimed invention directly bonds the membrane with the electrode substrates by using the good solvent, and does not provide an interlayer between the membrane and the electrode substrates. Therefore, the presently-claimed invention does not cause the problem whereby the thickness of membrane-electrode assembly is increased.

Applicants note that the present specification states that the "good solvent will usually be applied in an amount of 0.001 to 10 mg/cm<sup>2</sup>, and preferably 0.01 to 1 mg/cm<sup>2</sup>... [Too] high an amount leads to swelling and dissolution of the electrolyte membrane, resulting in deformation." (Specification, page 36, lines 18-24.) Thus, by keeping the amount of good solvent applied to 10 mg/cm<sup>2</sup> or less and preferably 1 mg/cm<sup>2</sup> or less, swelling and dissolution are avoided.

### **The Outstanding Rejection**

The Office Action rejected claims 1-11 under 35 U.S.C. § 103(a) as being unpatentable over the combination of Bonsel et al. (U.S. Patent No. 6,197,147) and Sompalli et al. (U.S. Patent No. 6,524,736). This rejection is respectfully traversed.

Bonsel et al. discloses a process for continuous production of membrane-electrode assemblies wherein to bond the components, the electron-conductive material or at least one flat face of the membrane or both components are continuously coated with a solvent or a polymer solution. However, in the Examples of Bonsel et al., it is only disclosed that a solution of sulfonated polymer identical to the membrane material is applied to both faces of the membrane (Example 3). It is not disclosed that a good solvent is applied to at least one of the facing surfaces of the opposed electrode substrate and the electrolyte membrane, in order to bond the membrane with the electrode substrates. Bonsel et al. also suffers from the problem that by applying the sulfonated polymer solution to the surfaces of the membrane an interlayer is formed between the membrane and the electrode substrate, and the thickness of membrane-electrode assembly is increased. Further, the object of Bonsel et al. is apparently to cause swelling. In particular, Bonsel et al. states that the adhesion is improved "by swelling in mixtures of a solvent." (Column 6, line 28.) Thus, Bonsel et al. would not be expected to, and actually clearly teaches against, limiting the amount of solvent utilized to avoid swelling.

Sompalli et al. discloses that when preparing a membrane electrode assembly, "it is important to have an electrode with a relatively homogenous porous structure and which has good structural integrity" which is achieved by using a process that

"significantly reduces excessive 'mud-cracking' of the electrodes during the drying stage." (Column 4, lines 51-57.) The process entails forming an electrode on a substrate by applying a catalyst slurry containing a solvent, which evaporates to form the electrode film. (Column 6, lines 6-10.) The electrode film is then applied to the membrane using a "decal" transfer process involving hot pressing, and the substrate is removed from the back of the electrode film after the membrane and electrode have bonded. (Column 7, lines 41-66.) No solvent is applied to either of the membrane or the electrode as a step in the transfer process.

Sompalli et al. fails to remedy the deficiencies of Bonsel et al., as it does not disclose using any solvent during the step of bonding an electrode to a membrane, much less using 0.001 to 10 mg/cm<sup>2</sup> of solvent. The only solvent used in Sompalli et al. is found in the slurry of the electrode material that is applied to a separate substrate, and the solvent is evaporated prior to the step of bonding the electrode to the membrane. (Column 7, lines 41-45.)

The Office Action maintains the rejection over Bonsel et al. and Sompalli et al., citing the following reasons: Bonsel et al. discloses a process for continuous production of membrane-electrode composite wherein to improve the adhesion and to bond the components, the contacting material or at least one flat face of the membrane or both components can be incipiently dissolved, wetted or incipiently swollen by a solvent, and the components can then be fitted together by pressing and bonded by lamination. Although Bonsel et al. does not specifically teach wherein the good solvent for the electrolyte membrane is applied to at least one of facing surfaces of the opposed electrode substrate, Sompalli et al. teaches that a robust electrode, wherein electrode

shrinkage and cracking of the electrode are prevented, is formed by coating a porous support substrate with a wetting solvent and then applying an electrode slurry.

However, Applicants respectfully disagree with this interpretation of the cited art.

In Sompalli et al., the wetting solvent is used in coating the pores of the porous support substrate in order to efficiently remove the solvent from the electrode slurry applied to the porous support substrate. That is to say, in Sompalli et al., the solvent is not coated on the interface between the membrane and the electrodes, and the object of using the solvent is not to improve the bond strength between the membrane and the electrodes. Therefore, the object of Sompalli et al. is different from that of the claimed invention.

Further, in Bonsel et al., the membrane is incipiently dissolved, wetted or incipiently swollen by a solvent, and then the membrane and the electrode are bonded. That is to say, Bonsel et al. intends to use a large amount of the solvent to dissolve or swell the membrane. On the other hand, in the claimed invention, the good solvent is used in minimal amount, 0.001 mg/cm<sup>2</sup> to 10 mg/cm<sup>2</sup>, such that the adhesion between the electrolyte membrane and the electrode substrate is not poor, and the membrane is not deformed by swelling or dissolution. See page 36, lines 18-24 of the specification. Therefore, the technical intent of Bonsel et al. is different from that of the claimed invention.

Thus, it is respectfully submitted that the combination of Bonsel et al. and Sompalli et al. does not disclose or suggest that a good solvent is applied in an amount of 0.001 to 10 mg/cm<sup>2</sup>, in order to avoid poor adhesion between the electrolyte membrane and the electrode substrate and to avoid deformation of the membrane by swelling or dissolution thereof. For at least these reasons, claims 1-11, each of which

requires the presence of such an amount of good solvent, are patentable over the combination of Bonsel et al. and Sompalli et al.

For the reasons set forth above, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 1-11 as being unpatentable over the combination of Bonsel et al. and Sompalli et al. under 35 U.S.C. § 103(a).

**A Prima Facie Case of Obviousness Has Not Been Established**

As set forth in MPEP § 2142, three basic criteria must be met in order to establish a *prima facie* case of obviousness. First, the prior art reference must teach or suggest all the claim features. Second, there must be some suggestion or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference. Finally, there must be a reasonable expectation of success. The teaching or suggestion to make the claimed modification and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

The first requirement for a *prima facie* case of obviousness, namely, that all claim features be taught or suggested, is not met here. Both Bonsel et al. and Sompalli et al. are entirely silent regarding applying a good solvent to at least one of facing surfaces of the opposed electrode substrate and the electrolyte membrane prior to pressure bonding, where the good solvent is applied in an amount of from 0.001 to 10 mg/cm<sup>2</sup>.

The second requirement is that the cited references or knowledge available to those of skill in the art must provide a suggestion or motivation for modifying the references to arrive at the claimed invention. This requirement is also not met. Bonsel

et al. fails to disclose or suggest pressure bonding by applying from 0.001 to 10 mg/cm<sup>2</sup> of a solvent to at least one of the facing surfaces of an electrode and an electrolyte membrane, and Sompalli et al. fails to disclose or suggest applying any solvent before the step of pressure bonding an electrode to an electrolyte membrane. The suggestions and motivations for modifying the solvent contained in the catalyst slurry of Sompalli et al. for use in the process of Bonsel et al., as set forth in the Office Action at page 3, appear to be based entirely on impermissible hindsight reasoning and the guidance provided by Applicants' disclosure. No evidence has been provided to demonstrate that any such suggestion can be found in the knowledge available to those skilled in the art. Applicants submit that there is no motivation for one skilled in the art to alter the disclosures of Bonsel et al. and Sompalli et al. to arrive at the presently-claimed invention.

Finally, Applicants submit that no disclosure in the cited references would lead one of skill in the art to have reasonable expectation that the modifications proposed in the Office Action would be successful. Such an expectation of success may not be based on Applicants' disclosure.

Accordingly, Applicants submit that no *prima facie* case of obviousness has been established, and that one skilled in the art would not find any suggestion or motivation to modify the disclosures of either of Bonsel et al. or Sompalli et al. to arrive at the presently claimed invention. Bonsel et al. or Sompalli et al., individually or in combination, do not teach or suggest all of the features of claims 1-11, and Applicants therefore respectfully request that this rejection be withdrawn.



### Additional Comments

Pages 3-4 of the Office Action indicate that the application of from 0.001 to 10 mg/cm<sup>2</sup> of a solvent to one or both of the facing surfaces of the membrane and the electrode was considered to be inherently present in Bonsel et al. Applicants respectfully disagree.

Bonsel et al. states that the membrane thickness is from 0.1 µm to 10 mm. (Column 3, lines 49-51.) The electron-conductive contacting material, i.e., the electrode, is from 10 µm to 1 mm thick. (Column 3, lines 6-8.) Bonsel et al. also indicates that coating of solvent or polymer solution that is applied to the membrane and/or the electron-conductive contacting material is from 1 µm to 200 µm thick. (Column 6, lines 50-52.) Bonsel et al. indicates that this coating is applied to improve adhesion and bond the components by dissolving, wetting, or swelling the electron-conductive contacting material and/or the membrane. (Column 6, lines 35-39.)

Applicants' electrolyte membrane is from 10 µm to 100 µm thick, and Applicants' electrode substrate is from 5 µm to 100 µm thick. The good solvent is applied in an amount from 0.001 to 10 mg/cm<sup>2</sup>, where the range is specifically selected to avoid using too much solvent, which leads to swelling, dissolution of the electrolyte membrane, and undesirable deformation. (Specification, page 36, lines 18-24.)

The Office Action states that "the coated membrane of Bonsel et al. has a thickness that falls within the range of the thickness of the coated membrane of the instant application." However, Applicants submit that one skilled in the art would not conclude that the 1 µm to 200 µm thick coating of solvent and/or polymer that is applied by Bonsel et al. before bonding the membrane and the electrode together results in the

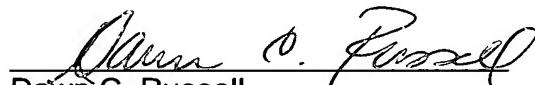
necessary presence of Applicants' claim feature whereby good solvent is applied in an amount from 0.001 to 10 mg/cm<sup>2</sup>. In fact, Bonsel et al. teaches away from this feature of Applicants claims. Bonsel et al. specifically states that the 1 µm to 200 µm thick coating of solvent and/or polymer results in dissolution or swelling of the membrane and/or electrode. Applicants' disclosure indicates that the 0.001 to 10 mg/cm<sup>2</sup> application of good solvent avoids dissolution and swelling. One skilled in the art therefore would conclude that Bonsel et al. teaches away from the step of applying from 0.001 to 10 mg/cm<sup>2</sup> of a good solvent.

## CONCLUSION

In view of the above remarks, Applicants respectfully submit that all of claims 1-11 are in condition for allowance. Favorable consideration and prompt allowance of the claims and this application are earnestly solicited. Should the Examiner believe anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' representatives at the telephone number listed below.

In the event this paper is not considered to be timely filed, Applicants respectfully petition for an appropriate extension of time. The Commissioner is authorized to charge payment for any additional fees that may be required with respect to this paper or credit any overpayment to Counsel's Deposit Account 01-2300, making reference to Attorney Docket No. 026035-00010.

Respectfully submitted,



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